Globelics

Biofuels production in Mexico a complex problem

R. L. González-Aguirre[1]
R. Quintero-Ramírez[2]

Introduction

In Mexico the possibility of producing biofuels has generated a wide range of political, economical and technical comments and opinions. This is due mainly to the fact that the oil industry has contributed heavily to the direct financing of the Mexican government for the last 70 years, in 2007 this income represented 37% of the total expenditure of the Government and any change to this situation is looked upon with great suspicion and so there are not clear strategies of how to bring renewable energies (v. gr. bioenergy) into Mexico.

The analysis of the present and future of energy, especially oil, has become complex and difficult. Several points of view concerning biofuel production have created at least two groups: one that is in favor because bioenergetics are a better source of fuels, its renewable nature goes quite well with the notion of sustainable development and in some instances it is looked as a way to help and support rural development, particularly in poor areas; the second group opposes biofuel production considering that there will be a competition for resources between agriculture for food and feed purposes and energy, and that from the perspective of climatic change biofuels are not an answer in the long run; one of the main oppositions comes from the oil company, PEMEX, which has operated as a government monopoly and the production of the biofuels in some way will open up its structure and the company will have to share its enormous power.

The major differences and discrepancies among groups are on the economic impact, where questions such as: who will pay for the subsidy required for biofuel production?, how will biofuel be introduced into the market?, what are the real and true benefits and problems associated with biofuels?. They have not been answered.

In this presentation we will discuss three different perspectives about biofuels production, in order to propose some scenarios and guidelines for a national program in this field.

[1] Department of Sociology, Metropolitan Autonomus University, Unit Azcapotzalco, rosaluz@correo.azc.uam.mx
[2] Department of Processes and Technology, Metropolitan Autonomus University, Unit Cuajimalpa, quintero@correo.cua.uam.mx

Economic importance of oil

Mexico has been an important oil world producer, exporting in 2006 more than 1.95 million barrels per day (mbd) but having produced in 2004 more than twice that quantity. In recent years the main oil fields have started to decline, for example Cantarell field has passed from 2.2 mbd in 2003 to the present production of only 1.05 mbd, and for 2012 it is expected that the total national production will go down to 1.4 mbd. At the same time the country is a net importer of fuels such as gasoline, diesel, turbosine, natural gas, etc., with a yearly increase in demand of 7.1%. In 2008, 334,500 barrels of gasoline per day are imported representing almost 40% of the national consumption with an estimated cost of more than 14,700 million dollars.

In table 1, data on oil production from 2002 to 2008 is presented, it can be seen the decline in production and exportation of oil and the dramatic increase importation of fuels specially, in the last 3 years. The economic impact of this situation has not been fully recognized because the international oil prices have been so high that the oil income has even increased, but in the long run it will diminish. Nevertheless all information concerning oil production indicates that in the short term Mexico can become a net oil importer.

Table 1. Production, exportation and importation of oil products in Mexico (2002-2008)

Year	Production	Exportation	Importation	
	mbd	mbd	gasoline tbd	Other fuels tbd
2002	3.585	1.790	89.7	243.6
2003	3.789	1.844	54.5	199.9
2004	3.825	1.801	94.9	234.2
2005	3.760	1.838	169.8	333.7
2006	3.683	1.959	204.7	368.9
2007	3147	1.704	308.1	495.9
2008	2847	1.454	334.5	539.5

mbd (million barrels per day), tbd (thousand barrels per day)

Source: PEMEX Statistics

Another products that are imported and added to gasoline to reduce emission of toxic gases, are oxygenated chemicals which are known as MTBE and TAME. As it will be seen later the initial government program on biofuels has used them as its target.

So Mexico has a paradoxical situation, it is a declining exporter of oil and is increasingly dependant on fuel importation, and the *status quo* concerning its hugh economical income and its distribution are difficult to change even that today this is matter of great political interest and many groups are discussing them.

Another issue that difficults the establishment of new policies concerning fuels is that its consumption is heavily subsidized, for 2008 its estimated that the subsidy for gasoline and diesel will reach almost 19,500 million dollars; the total subsidy for fuels, gas and electricity amount to almost 40% of the total income of oil production (64% goes to gasoline and diesel).

This year, the President sent an initiative to the Congress with the purpose to carry out profound changes in PEMEX to solve its present difficult situation, this so called Energetic Reform has not been able so far to reach consensus about how to do it or establish a strategic plan to obtain improvements in the operation of PEMEX and to eliminate barriers for the investment of private capital.

Agricultural resources for biofuel production

In the world presently, there are only two biofuels on the market, bioethanol which is obtained from two different agricultural raw materials, in USA the production of ethanol is based on the biological transformation of starch from corn into liquid ethanol, and in Brazil sugar cane is used as the main carbon source for its production; the other biofuel is called biodiesel and its production is based on the chemical transformation of vegetable oils (v. gr. soybean, palm, cotton, etc). In both cases they are mixed with traditional fuels, gasoline and diesel respectively. For example in 2007, production of ethanol in USA was 6,499 million gallons per year (mgy) and in Brazil 5,019 mgy. The enormous amount of corn and sugar used has had the impact of creating an increase in food prices and now exists a new issue of food vs. energy. To evaluate the production of biofuels in the country is necessary to review status of corn and sugar production.

The production of corn is very important, more than 3.1 million farmers work directly on the field and almost 12.5 million people depend on it, but there is a growing need for importation of corn, for example last year 11 million tons of corns were imported mostly from USA and 22 million of tons were produced internally. The productivity of this crop varies strongly between the different producing regions, in some of them: Sinaloa, Guanajuato, it reaches more than 10 tons/hectare-year, but in others like Oaxaca is less than 1, being the national average 2.3. In table 2 it is shown that Mexico is a large importer of food, and the dependence on food importation has increased in the last few years not only for corn, but also for other important grains: wheat, rice, barley, oat and beans. It is accepted that there is not self-sufficiency in corn and vegetables oil products.

Table 2. Importation of grains and vegetable oils in Mexico (2005-2006)

	2006 tons	2005 tons
Corn and sorghum	13,645,319	11,483,390
DDGS of corn	428,430	189,380
Wheat	3,182,090	3,554,610
Soybeans, pasta and soy oil	5,194,500	4,903,700
Pulp and cotton seed oil	298,900	234,600
Beans	76,450	39,600
Rice	757,500	705,800
Barley	14,100	8,600
Oat	800	7,100
Total	23,602,672	21,172,414

Source: Advisory Group of Agricultural Markets, CIDE.

In the case of sugar cane, its production is also important: a total of 500,000 jobs are associated with it, the production reached is 54 million tons of sugar cane in 2005 and it has declined to 48.6 millions in 2007; and bit more of 5.4 million tons of sugar (saccharose) are generated each year, and almost 0.5 million have to be stored because the cost of production its much higher than the international price. But this situation is even more complicated when you consider that fructose (can replace saccharose in industrial products) is also imported from USA, more than 0.5 million tons per year. Fructose is obtained from the enzymatic transformation of starch from corn.

For biodiesel production they are required different sources of vegetable oils, as it can be seen in table 2, the country is a net importer of soybeans, soybean oil and cotton oil. So to produce biodiesel new raw materials are required; several groups (companies and universities) have selected *Jatropha curcas* as this vegetable source for biodiesel, but they have only initiated its agricultural production in several states: Michoacán, Chiapas and Yucatán.

As it has been shown in this simple and brief analysis, the agricultural sector has large and profound problems that have not been solved in the last 40 years and now, when biofuels arrive, there are not clear routes of how to discuss, analyze and take decisions about its production. Nevertheless in February of this year, the Congress passed the Law for the Promotion and Development of Bio-fuels (known as the Law on Bioenergetics), which appeared after a long, complex and difficult discussion in Congress and different government agencies, among them: Secretary of Agriculture, Secretary of Energy and Secretary of the Environment; the result is a Law that promotes biofuel production and consumption, but it does not state how this will be done.

Biofuels from a technical point of view

The terms biofuel, bioenergy and renewable energy, cause confusion even among experts on what do we mean exactly by those words, so its definition is important because focuses the analysis and limits the scope of the discussion. Biofuels in this presentation is defined as the fuel obtained from agricultural resources, trough either biological or chemical transformation or both; and the products either ethanol or biodiesel will be used in a mixture with gasoline for example of ethanol (E10) means gasoline containing 10% of ethanol or with diesel (B2 recently was approved in Brazil) 2% of biodiesel and the rest is traditional diesel.

From a technological point of view biofuels is an emerging area and according to its stage of development they have been classified as first, second and third generation.

In table 3, the present state of the art for biofuels is presented: first generation means that they are produced today commercially in some part of the world, for example bioethanol in USA, Brazil, China and Colombia; and biodiesel in Brazil, Germany, Argentina and other members of the EU; second generation biofuels are expected to be available in large amount in the next 5 years and even that they use the same raw materials as the first generation, they do not compete with food because the raw material that is transformed is the non-edible part of the plant, known as lignocelullosic material such as bagasse, straws, stems, leaves, etc.; and third generation are new biofuels which we are not sure at this time if they will meet the requirements of present fuels in terms of energy content, price, availability and waste

generation, some of the most mentioned in the scientific literature include biogasoline and biohydrogen.

To produce second and third generation biofuels, it is being considered the option of development of transgenic plants with either higher content of cellulose, lower quantity of lignin or higher productivity.

Table 3. Different types of biofuels by its stage of development

Raw material	Biofuel generations		
	I	II	III
Corn	Ethanol (starch)	Ethanol (cellulose) Butanol (starch)	n-hydrocarbons biogasoline
Sugar Cane	Ethanol (sugar)	Ethanol (bagasse)	n-hydrocarbons biogasoline
Wood		Ethanol (chips)	
Agricultural residues		Ethanol (cellulose)	
Soybean (oil)	Biodiesel		
Other oils (plants or industrial)	Biodiesel		
Jatropha curcas		Biodiesel	
Algaes *		Biodiesel	
Starch from other sources (wheat, cassava, etc)			Ethanol n-hydrocarbons biogasoline
Non-domesticated plants			Ethanol and biodiesel
Transgenic plants			Ethanol and Biodiesel
Other domesticated plants (switchgrass, eucalyptus, etc.)			Ethanol (cellulose)
Unknown			Biohydrogen

*it is still undecided which will be the CO_2 source.

Bioethanol of first generation is used massively in USA, Brazil, Colombia and China; and biodiesel of first generation consumed in Brazil, Germany, Argentina and other members of the European Union; second generation biofuels refer also to ethanol and biodiesel but the main change is that raw material will be a non-found product; many groups of research around the world have focused on lignocellulosic materials, such as care.

Stover, sugar cane bagasse, woodchips and other agricultural residues is expected that they will be.

There is a lack of promotion for the development of renewable sources of energy country. For biofuels after the Law on Bioenergetics a commission constituted by the following Secretaries

has been set up: Agriculture (SAGARPA), Energy (SENER), Economy (SE), Environment (SEMARNAT) and Finance (SHCP), but as we will seen in the next section there are problems of focus and each Secretary follows its own agenda.

With regard to research on biofuels, we can only say that in the whole field of bioenergy there are 50 specialist, but working on biofuels less than 20[1].

National Program for biofuel production

In order to formulate a National Program to promote and support biofuel production, several steps have to be taken. One of the first ones, is a critical review of what has happened in countries where biofuels has been a success, which indicates that there are at least 4 success factors:

- There was a strong political in the Government because the country was a large importer of oil, 75% in the case of USA and 80% in Brazil.
- They based production on a crop where they are world leaders: USA for corn and Brazil in sugar cane. Another interesting example is Colombia that uses sugar cane because it can produce it almost all year around.
- The Program has had a long term view and its goals were set up at high level since the beginning. Now for instance, in Brazil ethanol production is considered a great opportunity that started as a dangerous need.
- During the first years of the Program, research and development projects and production facilities were subsidized, and even today at large commercial scale they keep receiving financial support, it is estimated that only in USA the total subsidy amounts is 11 billion dollars.

To set up a National Program on Biofuels, it is also important to establish scenarios of production as well as the answer to the following questions:

- Do we really need biofuels in the short and medium term?
- What is the demand for biofuels?
- Is Mexican agriculture ready to support a large effort on biofuels?
- If biofuels are produced, how will be integrated in the present system of energy?
- Is it a real opportunity the production of biofuels as an area of development and business, like in Brazil and Colombia?
- How the economic benefits of biofuels will be distributed among different sectors?
- What are the social and political impacts of producing biofuels taken into consideration that first generation products compete directly with food?

This is a complex situation, it has many unknown factors, and many groups should participate in the discussion and decision taking process, these stakeholders should present proposals and indicate clearly their interests.

The Law on Bioenergetics has provided a driving force inside the Government and the private sector to start evaluating future projects but more important to recognize the need of a National Program on Biofuels that integrates them into the energy basket of the country.

In March of this year, an Inter-Secretarial Commission was formed, it consists of 5 different Secretaries, but 3 of them (Energy, Agriculture and Environment) play not only the role of

coordination/administration of activities, but have specific goals and programs. A general comment about this Commission is that is lacks enough political power to prepare and support one and one policy for biofuels. Each Secretary has taken steps in the field of biofuels production with different emphasis and purposes among them. For example, the Secretary of Energy (SENER) in recent meeting on Bioenergy[2] present the bases of its policy for biofuels, indicating that for year 2012, 15-20% of all energy consumed should come from a renewable source and that biodiesel offer better benefits so its production was going to be support it; among the reasons of promoting production of biofuels was the convenience in terms or rural development, energy security and environmental impacts; surprisingly PEMEX is not considered in the analysis and the needs and requirements for gasoline and diesel are not mentioned.

In the case of the Secretary of Agriculture (SAGARPA) there is a major interest to support in the short term the production of biofuels; it has established the Program for the Scientific and Technological Development for the Sustainable Production of Materials for Bio-fuels[3], its main objective is to support the sustainable production of raw materials for biofuels that will allow diversifying the income for agricultural producers in Mexico, improving their competitiveness, while attending the food supply chain for the Mexican domestic market and exports; the program has two specific goals:

- Biomass to produce ethanol: substituting on a first stage 2% MTBE with ethanol, based on the demand SENER-PEMEX for the urban areas of Guadalajara, Monterrey and Mexico City. In table 4, the estimated targets are presented, as it can be seen the program will start in Guadalajara this year with a capacity of 200 million liters per year which for ethanol production a medium size facility, according to press information ethanol will be produced from sugar cane.

Table 4. Production goals for raw materials to obtain ethanol in Mexico

Metropolitan areas	Ethanol (million liters per year)	Required surface (thousand hectares)	Estimated biomass (millions of tons per year)	Period
Stage 1. Guadalajara	200	45	3.0	2008-2010
Stage 2. Monterrey	150	35	2.3	2008-2011
Stage 3. Mexico City	530	120	8.0	2008-2012
Total	880	200	13.3	

Source: SAGARPA

- Biomass to produce bio-diesel: developing cultivars that do not enter in competition with the production of foods, and also contribute to improve the income of producers in a sustainable manner; there are several cultivars on evaluation but the most promising seems to be *Jatropha curcas* but production targets or dates have not been proposed.

Also the Secretary of Environment (SEMARNAT) has started to review the potential impacts that biofuels will have on the atmosphere, especially with regard to green-house gas

emissions. It is well accepted that biofuels of first generation do not offer a great advantage over gasoline and diesel when the analysis takes into account the net energy balance and gas emission related with their production and consumption.

At the same time, in several states governments and the private sector have financed large industrial projects, unfortunately the information in most cases come from the press and capacity and investment figures are not be precise. In Sinaloa, 2 new production plants for ethanol from corn have been built and it seems that the product will be exported to USA; in Jalisco, 2 already established sugar-cane refineries will produce ethanol from sugar cane and few weeks ago the state of Tamaulipas announced the construction of an ethanol plant that will be sorghum as raw material. For biodiesel there are also several developments in different states, all with federal or local support and in some of them it has been commented that large international companies will participate. The main projects are: biodiesel from *Jatropha curcas* in Michoacán and Chiapas (this State create the Institute for Bioenergetics of Chiapas); in Yucatán and Tamaulipas there are plans to start cultivation of *Jatropha* in the next few months; another group of projects are considering the producing of algae, in Sonora and in Quintana Roo these efforts are financed by USA companies.

Our conclusions about the state of development of biofuels in Mexico and the status of a National Program for them are the following:

i) So far the discussion and analysis on biofuels has been mainly taking into consideration political concerns.
ii) The participation of academia and scientists in general has been marginal and the human resources in the field are quite small[1].
iii) All known policies do not really support national development, in some instances it seems that the projects are subsidies to the agricultural sector or in others that the main interest comes from outside.
iv) The already use of funds to finance and support ethanol projects in Sinaloa, Jalisco and Tamaulipas, has not been clear and in both cases ethanol from corn or sugar cane it is known that they must receive subsidies in order to operate.
v) The strategy for introduction of biofuels into PEMEX has not been set up, the impacts on biofuels utilization have not been studied or analyzed in detail and in general there is a felling that Mexico is entering into the biofuels arena without a careful and critical evaluation of its benefits and consequences.

References

1. Aguillón, J., Panorama de los bioenergéticos y criterios de sustentabilidad para biocombustibles, presented in Foro Avances en Bioenergía, organized by Iberoamericana and Universidad Autónoma Metropolitana Unidad Cuajimalpa, México, D.F., June 3, 2008.

2. Herrera, J., Bioenergéticos avances en su desarrollo, presented in Foro Avances en Bioenergía, organized by Universidad Iberoamericana and Universidad Autónoma Metropolitana Unidad Cuajimalpa, México, D.F., June 3, 2008.

3. Villalobos, V., Program on the Scientific and Technological Development for the Sustainable Production of Raw Materials for Bio-fuels, presented in The American

Congress on Plants & Bioenergy, organized by the American Society of Plant Biologists, Mérida, Yucatán, June 23, 2008.